THE SHALLOW BAY WETLAND

AN ANALYSIS OF ITS NATURAL HISTORY AND A PLAN FOR PROTECTION

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SUMMARY:

Shallow Bay is a 230 hectare wetland at the south end of Lake Laberge in the southern Yukon. It has been central to the original use of the area by the Ta'an Kwachan first nation. It is an important waterfowl staging area; a key fish spawning and rearing area, and is used by moose, beaver, bear, mustelids, muskrats and a host of bird species. We found 36 species of water birds using the area; banded waterfowl showed birds from all North American flyways except the Atlantic were using the area. Most use by water birds was for staging although at least 4 species were breeding. Over 100 species of songbirds were observed and at least 17 species were breeding. Wood frogs, and 9 species of fish were identified. 6 species of birds of prey were found hunting in the wetland; only N.goshawk was found breeding. The vegetation community consists of three major zones: aquatic, emergent and riparian periodically flooded shrub. Water of the bay is mostly from the one small inflow creek, Horse Creek, although annually silts from the major Yukon drainage contribute to the benthics of the wetland. Critical to the area's ecology is the hydrologic regime of annual flooding of the emergent and riparian shrub zones. The flooded riparian zones are heavily used by brood rearing water birds and by many thousands of young fish. Benthic and aquatic invertebrates represent much of the area's biomass. Protection measures and planning for the areas future must include controlling recreational use (including hunting, and motorized access), managing its unique water level regime, protecting its water inflow, and supporting is obvious considerable educational values. A legally protected habitat area will probably be required to ensure the critical process of the area continue in perpetuity.

INTRODUCTION:

The Shallow Bay Wetland is located approximately 20km North of Whitehorse, Yukon. It is an area approximately 2km long, with a maximum width of 1,6 km, and a total area of approximately 230 hectares. It is associated with the floodplain of the Yukon River drainage where it enters the south end of Lake Laberge. In 1980, a larger area including the wetland was identified as ‘critical’ wildlife habitat by map notation for Land Use decision purposes (Yukon Waterfowl Management Plan, 1995). This designation was based on the obvious concentration of water bodies in the area including a large ox-bow, smaller side channels, and a separate shallow lake (Swan Lake). The area has been known for generations to be of value to wildlife species and to local people. The Shallow Bay Wetland area is especially valuable to the Ta’an Kwäch’än, since this wetland lies on their traditional territory.

A major portion of the Yukon’s Biodiversity is contained within the Territory’s wetlands. Documenting wetland values at Shallow bay was a first step in developing conservation and management plans for the area.

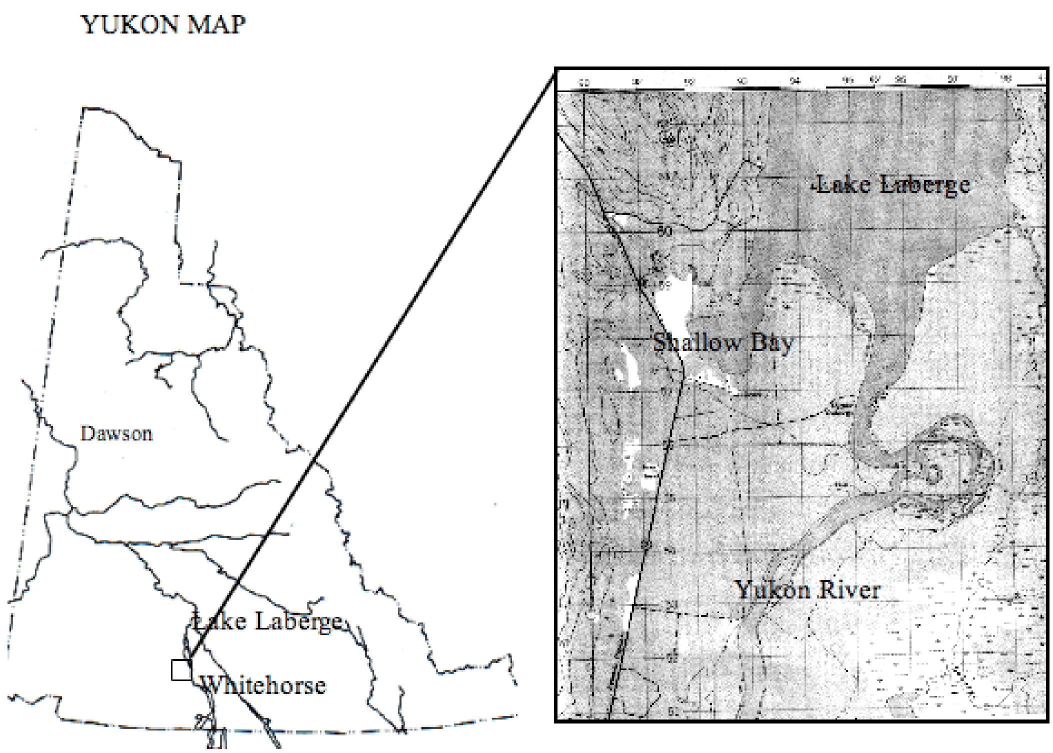


Figure 1. The location of the Shallow Bay Wetland in the south-central Yukon, in the Yukon River drainage. Latitude: 61:00, Longitude: 135:15.

The two major sources for this database are technical wetland analysis and local traditional knowledge of elders from the Ta’an

Kwäch'än First Nation. This report is an amalgam from a multi-year period of field research (1976-2007). The waterbirds of the area provide a powerful focus of study. They are totally dependant on the functioning of the wetland ecosystem; understanding their relative abundance, productivity and general use of the area gives a good ecosystem-level understanding of the critical features that will have to be protected if the wetland is to continue to function in the future.

STUDY OBJECTIVES:

Shallow Bay is under pressures for alienation to private possession; the apparent developments are for residential use and for removal of the riparian vegetation for hay production. The ultimate goal of this research was to quantify the ecological values of Shallow Bay to suggest a reasonable management plan. The tasks were to: a) build on existing information to assemble a more complete inventory, b) work in collaboration with the Ta'an Kwäch'än Council and their elders to better understand the traditional uses of the land, c) develop a better understanding of the ecological processes through the analysis of old and new data, and d) suggest conservation criteria for the future planning of the area based on the critical processes identified.

Figure 2. Shallow Bay, sedge and shrub emergents

FIELD METHODS:

This work has a long history. The original people of the area have a profound attachment to and knowledge of the area's natural history which dates from long before recorded history. Interviews with elders contributed the major part of the historic information we have of the area. Information about the traditional uses of the area has been gathered by the Ta'an Kwäch'än First Nations (Gotthardt, 2000). The science of assessing the area started in the early 1970's and has been conducted annually mostly by the second author, mostly as a sideline to other work. A major part to the current work was an effort by the first author to assemble and analyze that backlog of information. Ducks Unlimited (Can) did some engineering analysis and pre-planning research in the 1980's toward developing water management options for the area. The latter has contributed most of what we know about the structure of the water basin itself. We have also been able to draw on data collected by a variety of others: water flow analysis has been contributed over the years by the federal Water Survey and climate data has been collected locally since approximately 1900.

Throughout the summer of 2006 and 2007 both authors visited the area numerous times. We kept a running record of water birds, other bird species, wildlife, and water level. We conducted: two waterfowl brood searches; various breeding bird surveys; collected, pressed, and identified plants; and conducted two juvenile fish surveys, one of which was in partnership with Fisheries and Oceans Canada (DFO). We surveyed the depth of the pond with the help of a canoe and depth gauge, and the high water line was established with the help of a GPS unit. (Specifics of methods are in the appropriate sections below.)

STUDY TEAM, EDUCATIONAL OUTREACH:

In part because of this area's proximity to Whitehorse, a large public education effort was part of the research to inform the local community about the work and the importance of planning for the area. Local students at elementary schools through to college levels have attended the field study. Volunteer assistance was provided by numerous people, including: local residents, Conservation Officers with Environment Yukon, the federal Department of Fisheries and Oceans, Ducks Unlimited staff, and various local bird enthusiasts.

Figure 3. Youth from a local school class helping band ducks at Shallow Bay; some of the many individuals that assisted with the fieldwork.

FINDINGS:

ORIGINAL PEOPLE'S VALUES:

The Ta'an Kwäch'än have occupied the area of Shallow Bay long before the first European contacts. It was called *Man Tl'at*-Lake Bay. Archeological sites in the area indicate that it was occupied 3000 to 5000 years ago (Gotthardt, 2000). The more recent traditional use of the area by the Ta'an Kwäch'än First Nation people confirms the values they originally saw in the area. This has direct effects on the conservation plans for the wetland.

Ta’an Kwäch’än Traditional Use of the Land: Shallow Bay was a “breadbasket” area for the Ta’an Kwäch’än; a productive area they could count on. They would go there mainly in the fall to fish, and dry the fish, but sometimes also in the spring when other resources such as moose, ground squirrels, and hares were scarce or lean and poor. Several species of fish spawn in the spring and some families would go for that fishing opportunity. In October and November many families used to gather at the mouth of Horse Creek for the whitefish spawn. This location was one of the main whitefish fishing camps of the Ta’an Kwäch’än. Conical basket traps made out of willow poles, which measured 10 to 15 feet in length, were set in the shallow water at the mouth of the creek. Below the creek mouth a weir was constructed to block off part of the bay. People then advanced in the water rolling large willow structures to drive the fish into the traps. “Mrs. Irene Adamson recalled her grandmother, Maggie Broeren, told her that people from Hutshi and Carmacks used to come to *Man Tl’at* in the fall, to join Ta’an families for the whitefish spawn.” (Gotthardt, 2000). Pike and sucker were also abundant and harvested.

Figure 4. Northern Pike was a good source of food.[1]

One of the first recorded European contacts with the bay was on a mid-October night, in 1897, when New York Journalist Tappan Adney entered the bay. He sighted a camp with fires burning near the mouth of Horse Creek. As he approached the camp, he stumbled upon fish weirs, which blocked the entrance to the bay. The Ta'an Kwäch'än soon met Adney; accustomed to trading with the Coastal Tlingit First Nation, they met him with mountain sheep, ground squirrel, and fox skins. (Before the Goldrush, Shallow bay was also the rendezvous site for trade with the Coastal Chilkat First Nation.) (Gotthardt, 2000).

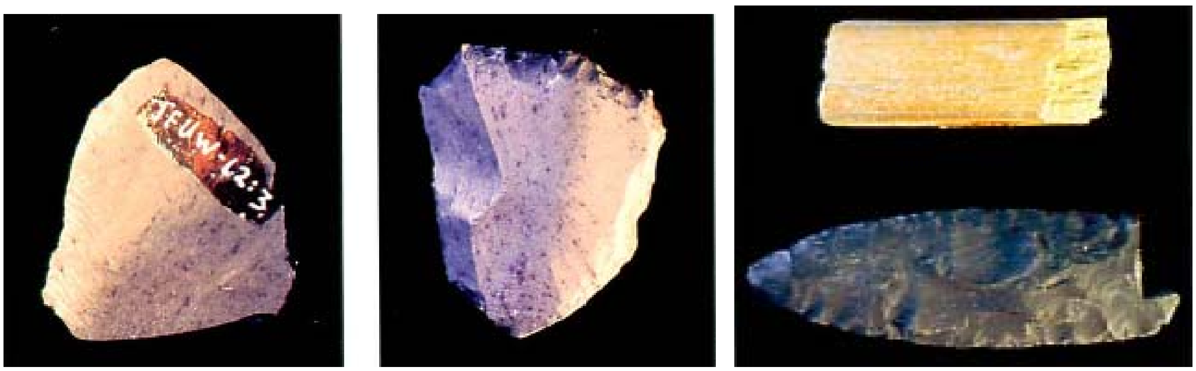


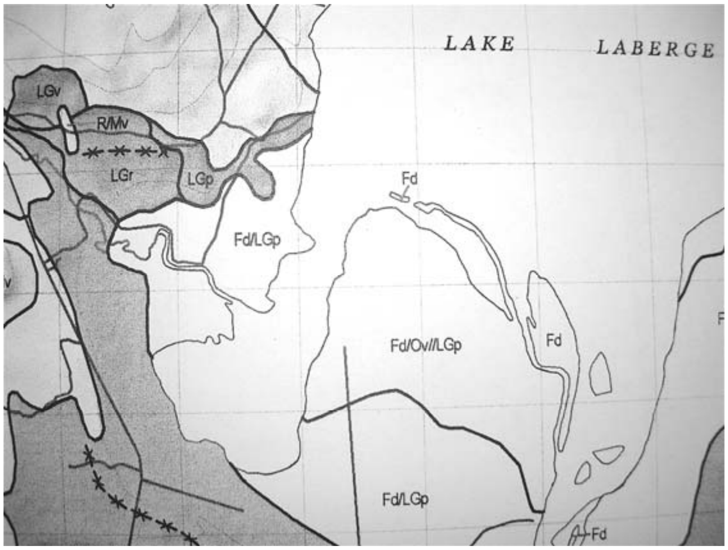
Figure 5. Above left and center are two views of a stone burin from an ancient hunting camp opposite the mouth of Kakwats'aneghru, along Lake Laberge.
Far right are a large lanceolate spear point and an incised bison rib from the same location.

Source: Ta'an Kwäch'än Heritage Booklet

Several sites around the shores of Shallow Bay were used for ceremonial cremation. Traditionally burnt remains were scattered at a specific site. In the late 1950's that particular site was totally burned over by a forest fire and all remains of bone, ceremonial buttons or clothing vanished. Today, some of these meaningful archeological sites are found on private land.

PHYSIOGRAPHY AND WATER BODY FORMATION: Shallow Bay is situated in the estuary floodplain where the Yukon River meets Lake Laberge, approximately 30 km downstream of Whitehorse. The bay is connected to Lake Laberge through a narrow channel. Shallow Bay is part of the water system of the South Central Yukon River drainage basin, and rests approximately 600m above sea level.

Lake Laberge is a remnant glacial lake from the Pleistocene. There is no permafrost in the immediate area. The substrate surface material of Shallow Bay forms a relatively flat bench.



Geological Abbreviation	Meaning
Fd	Fluvial deposits
LG	Glaciolacustrine Deposits
O	Organic deposits
R	Bedrock
M	Glacial deposits

Figure 6. Shallow Bay and surrounding geological composition. (Duk-Rodkin, 1999).

Glaciolacustrine deposits are responsible for the formation of the western edge of Shallow Bay. The general composition of the stratified deposits is: sand, silt and/or clay, ice-rafted stones, and slump structures. At the south and north ends of Shallow Bay, Holocene fluvial deposits make up the borders and substrate. These deposits generally consist of gravel and/or sand and/or silts, (Duk-Rodkin, 1999). Holocene river silts, coming primarily from the Takhini River, have constantly refreshed the bay’s substrate.

PROFILE AND HYDROLOGY:

Shallow Bay’s water level is directly affected by the water level in Lake Laberge,

Figure 7. Satellite image of the Yukon River’s, and Lake Laberge’s turbidity in contrast to Shallow Bay’s.

which is in turn mainly influenced by the Yukon River’s incoming flow. Two other water sources contribute to the bay’s waters: Horse Creek and the Takhini River. Horse Creek pours directly into Shallow Bay on the northwestern side. This contribution to the bay is significant to the ecosystem. In late summer, the creek’s water is apparently largely responsible for the water in the Bay. When the bay is at its lowest, water flows in a deep and narrow channel directly to Lake Laberge. Approximately 20km upstream, the Takhini River pours its turbid, silt laden, waters into the Yukon River. In spite of this heavy inflow of sediments, the water of Shallow Bay clears in summer, probably as a result Horse Creek’s inflow.

Since the substrate of the Bay is of lacustrine material, the profile of the wetland is very flat with the exception of a deeper channel carved by Horse Creek.

Basin profile surveys: In 1986 Ducks Unlimited Canada (DU) did a complete depth profile of the Bay (see figure 8). In 2006 the authors used a depth probe to investigate Shallow Bay’s floor profile from the SE side to the NW side.

Results from our profile survey showed the greatest depth to reach 1.9m. Water depth did not vary much throughout the center of the bay; it remained between 1.55m and 1.80m. The depth of Horse Creek was not investigated. The 1986 DU analysis showed a similar profile (figure 8).

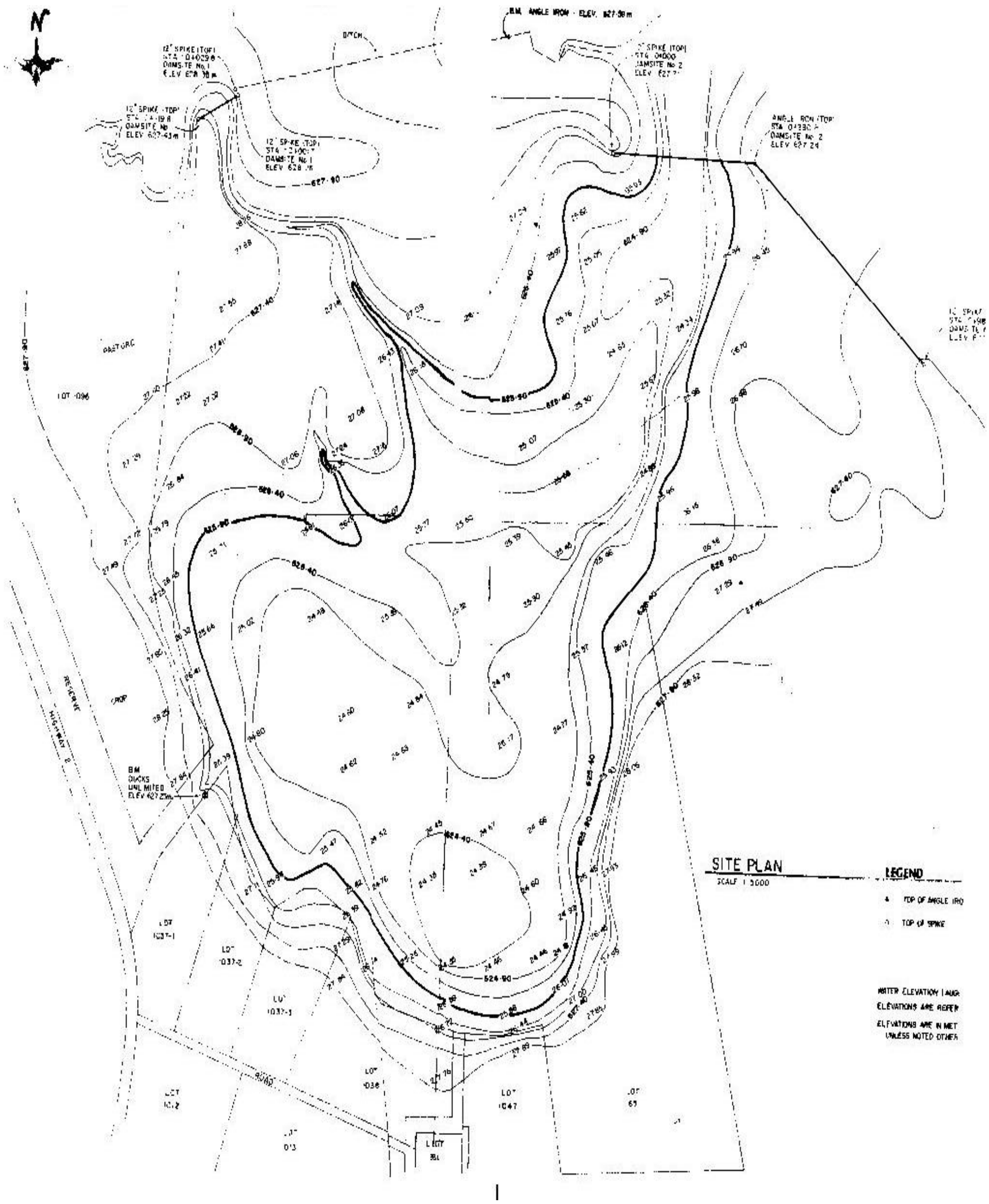


Figure 8. Basin profile (Ducks Unlimited, Canada, 1986)

Water Level Monitoring: Water level monitoring of Lake Laberge has occurred since 1980 by Water Survey Canada (WSC).

> **Water level surveys:** In the spring of 2006, we installed two water level gauges at the bay. One was installed in shallow water, while the other was installed near the

shrub line, higher in the basin. In early August, at peak water levels, we recorded the water edge by GPS at approximately 50 steps interval (table 1).

Date	Water level
August 5	171cm
August 8	170cm
August 12	168cm

Table 1. Survey dates and associated water level The GPS utilized measured to a precision about 11m. When we took five points on the same location and averaged them, a precision of approximately five meters was attained.

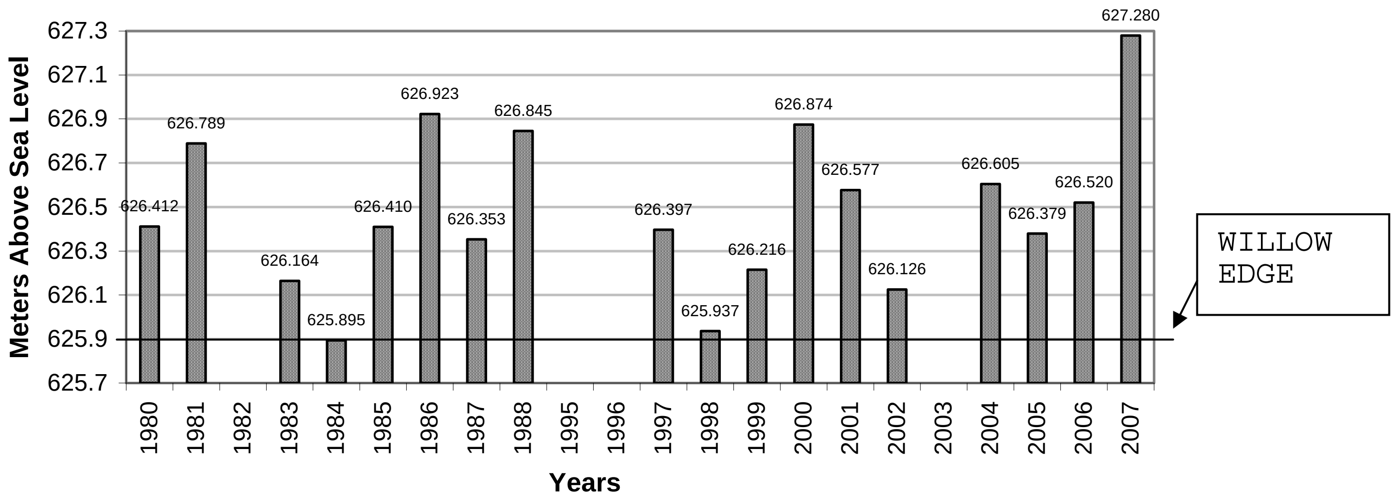
GPS points of the high water line were averaged and plotted on an aerial map of Shallow Bay (figure 9). On the South side of the Bay, the water level had already gone down. Although the ground was saturated in locations further inland, the high water mark was only taken when standing water was visible (usually connected to the main Body of water).

We found saturated soil extending far beyond the high water line, and at Shallow Bay it roughly correlated with the change from riparian shrub vegetation (willow) to upland species (poplar forest).

Figure 9. High water shoreline at Shallow bay
August 5-12, 2006

The main goal of the gauges was to tie Shallow Bay into a 20-year water level database collected at Lake Laberge (figure 10). From these, we determined that 2006 was an average year. The maximum water level recorded in 2006 was 826.5m above sea level (ASL), this represents a total water rise of 2.48 meters. 2007 was a record year. The highest measured water level was on August 8th, at 627.3m ASL, for a total water fluctuation of 3.15m.

Figure 10. Yearly Maximum Water Levels at Shallow Bay



The most important hydrological feature of this wetland is the extreme water level fluctuation throughout the year. The high water reaches its peak approximately in late July or early August (Appendix 4), and its low in the spring, around the end of April. As a result of this fluctuation, marshy edges with a prominent seasonally flooded shrub zone characterize this wetland.

VEGETATION:

Our results identified three vegetation zones: aquatic, emergent sedge, and emergent willow (figure 11). All undoubtedly function differently as the water level changes annually. Various *Potamogeton* species are the most common aquatic plants. A C*arex/ Triglochin* community is the lower seasonally flooded habitat and a dense riparian willow (*Salis spp)* community is the upper seasonally flooded habitat. The shrub zone converts from terrestrial to an emergent aquatic community in mid summer, and at that time it becomes the habitat by far the most heavily used by fish and waterfowl. In some locations, the height of the continuous willow stand reaches 3-4m. A poplar forest dominates the upper edge of the willows.

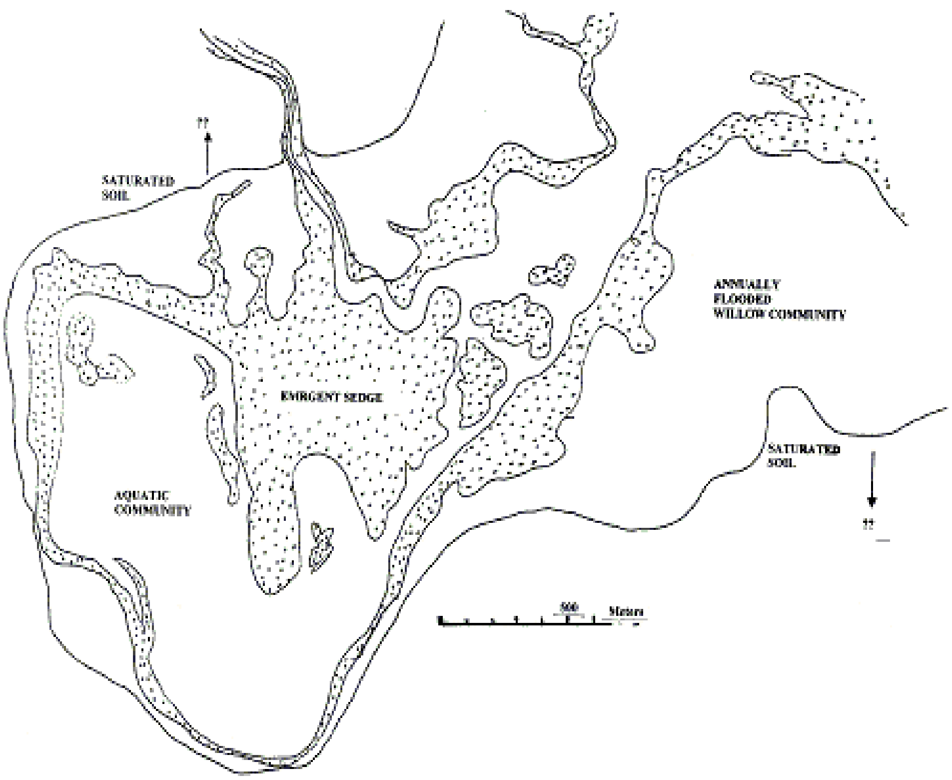


Figure 11. Vegetation Communities at Shallow Bay. Available aerial photos were used to map and outline the broad vegetation zones of the wetland.

The annually flooded riparian community is dominated by 4 species of willow *(Salix arbusculoides, S. bebbiana, S. glauca,* and *S. planifolia).* Pockets of dense sedge and grass occur within the willows. The sedge communities are mostly *Carex aquatalis* with the larger *C. rostrata* which is more associated with the willow community. The center-floor of the bay is rich with aquatic plants, primarily of pondweeds (*Potomageton)* species. Due to flat terrain and large water fluctuation, a long stretch of the sedge community forms a "wetland plain" periodically flooded. Plants that are adapted and dependent on this type of flooding have colonized this area.

Visually, the Channel carved by Horse Creek seems to possess very little, if any, aquatic vegetation. No samples were collected in this location. (Appendix 3 for the complete list of collected plants).

Figure 12. The flooded plain, emergent vegetation, and riparian willows of Shallow Bay, with the poplar forest visible in the background.

Figure 13. The vegetated seasonally flooded
Sedge community

Evidence of the yearly water level fluctuations is a light gray watermark prominent bark of willows (Figure 14). Ground cover plant species within that community are also identified as flood-adapted and dependent. This somewhat unique emergent community makes it very hard to make a clear delimitation of the high water shoreline since it is well hidden in the willows community’s thick cover.

Figure 14. High watermark on willows in the spring.

WATERBIRD POPULATIONS:

Survey Techniques: The principal field procedure was to take total counts of water birds from the ground. The first counts were initially done by air in 1982. In 2006 brood counts were conducted in late summer by canoe. **Banding:** Since 1987, the second author has periodically operated a waterfowl banding station at Shallow Bay. From 1987 to 1998 banding was done in the spring, and from 2003 to 2006 banding happened in the fall. We operated a fall waterfowl banding station in the area with the help of Yukon College students and local residents Katie Ostrum and Clay Martin. Typically the spring banding occurred from early May to July 1st and the fall banding from September 1st to freeze-up.

Species Diversity:

Thirty-six species (1 loon, 4 gull, 17 duck, 3 goose, 2 swan) and at least 2,000 individual waterfowl were found to be using the area annually (see Table 2). Shallow Bay is apparently primarily a spring and fall staging area with a relatively smaller breeding population.

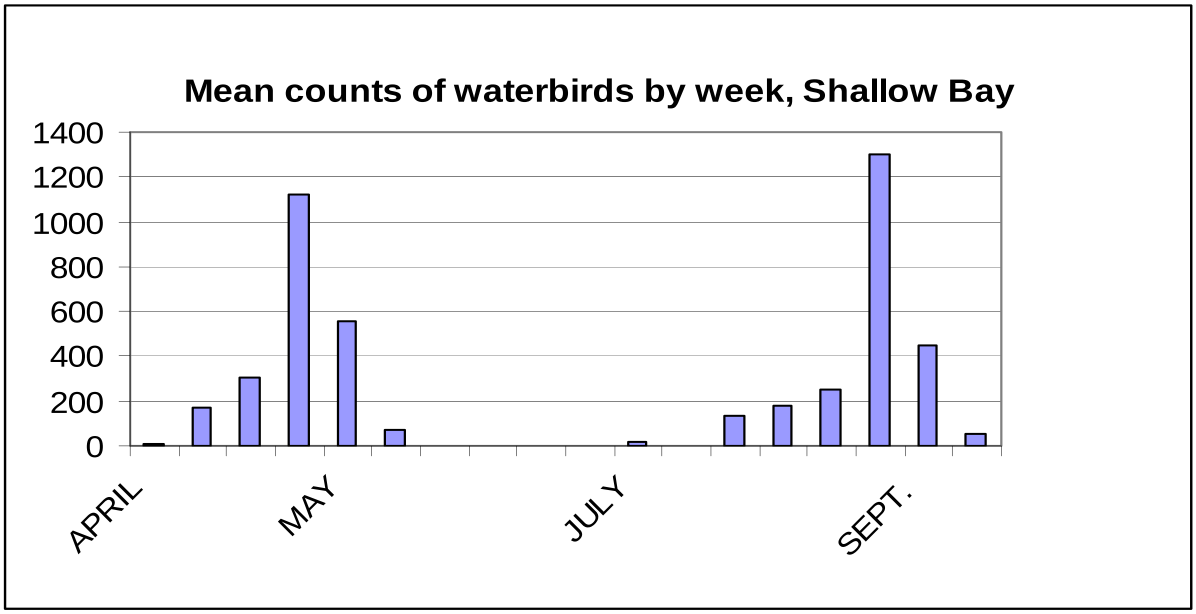


Table 2. Relative abundance of waterbirds from all survey counts from 1982-2006, (Shallow Bay, Yukon).

SPECIES	Percent of cumulative count
Mallard	17.50
Northern Pintail	16.30
Scaup spp.	12.37
Scooter spp.	10.94
American Widgeon	9.44
American Green Winged Teal	9.25
Northern Shoveler	5.03
Swan spp.	4.95
Bufflehead	3.01
Goldeneye	2.68
Gull spp.	1.80
Canvasback	1.74
Long-tailed duck	1.28
Merganser spp.	1.06
Loon spp.	0.70
Canada Goose	0.69
White-fronted goose	0.39
Blue Winged Teal	0.33
Ring-necked duck	0.24
Lesser Snow Goose	0.21
Arctic tern	< 0.1
Cinnamon Teal	< 0.1

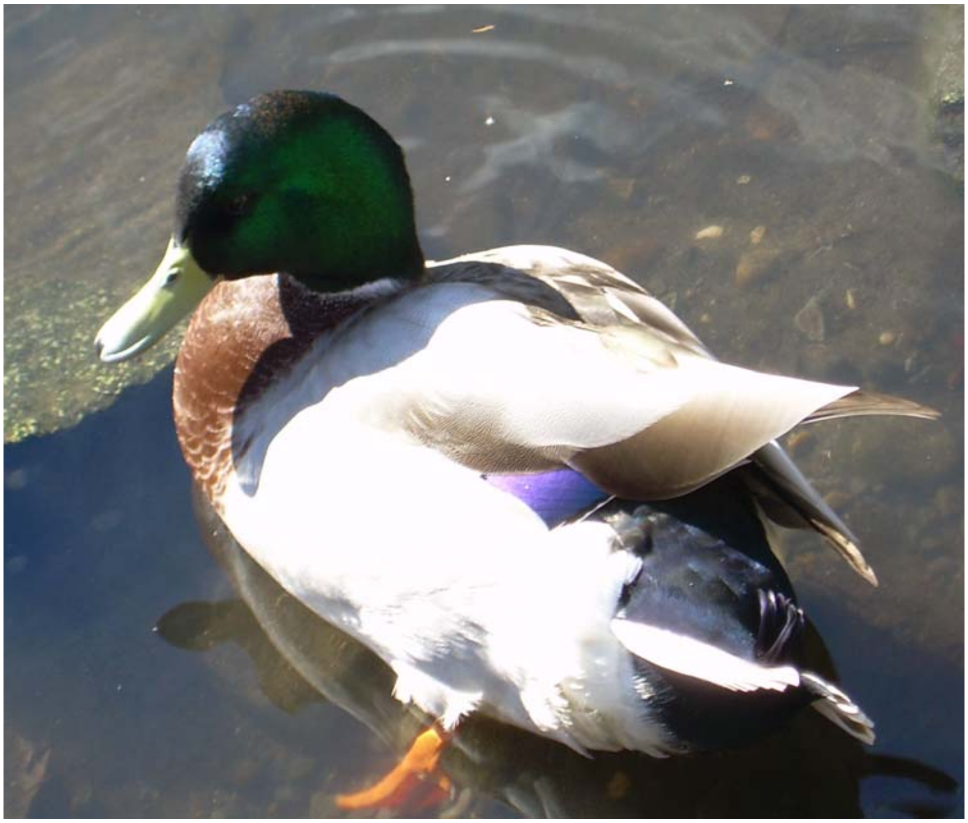
Shallow Bay is situated on a major migration corridor across the Southern Yukon. Fall (September until freeze-up) and spring (May and June) staging habitats are essential to the survival of continental waterbird populations. In the spring these habitats are the first waterbodies to be free of ice, and in the fall they supply waterfowl with concentrated food sources; they act as resting and “refueling stations”. The higher waterfowl occupancy in the spring and fall indicate that Shallow Bay is an important staging area for many species. The most common were: Mallard, A.G.W.Teal, N.Pintail, and A.Wigeon.

Figure 15. The major flyways known in the Yukon.

Banding Study:

A total of 3,917 water birds were banded, of those 236 have been recovered across North America (mostly by hunters).

Recaptures and band returns from other locations give an understanding of staging and wintering patterns. The return of bands from remote locations gives an indication of the migration patterns and the flyways used by these birds and indicates where



Mallard Drake, most fall bandings were of this species

Table 3: Banding Numbers and Recoveries			
Species	**# Banded**	**# Recovered**	**Recovery %**
Mallard	1176	105	8.93
A.G.W.Teal	2096	89	4.25
N.Pintail	325	17	5.23
A.Wigeon	210	23	10.95
B.W.Teal	95	2	2.11
Total bandings:	**3917**	**236**	**6.03%**

these waterbirds winter. Some indication of harvest pressure is also possible but mostly these returns give a valuable picture of the size of the continental ecosystem of which the wetland is part.

The Shallow Bay wetland serves a surprisingly broad region: literally all of North America flyways except for the far-east coast (Atlantic Flyway). Many returns are from the Pacific Flyway states as has been found from other Yukon weltands studied (Mossop, 1990). Birds also favored the Central Flyway, scattering across at least as far east as the Mississippi, and as far south as Mexico (Figure 17).   Figure 8 shows the rate of recovered bands by species.

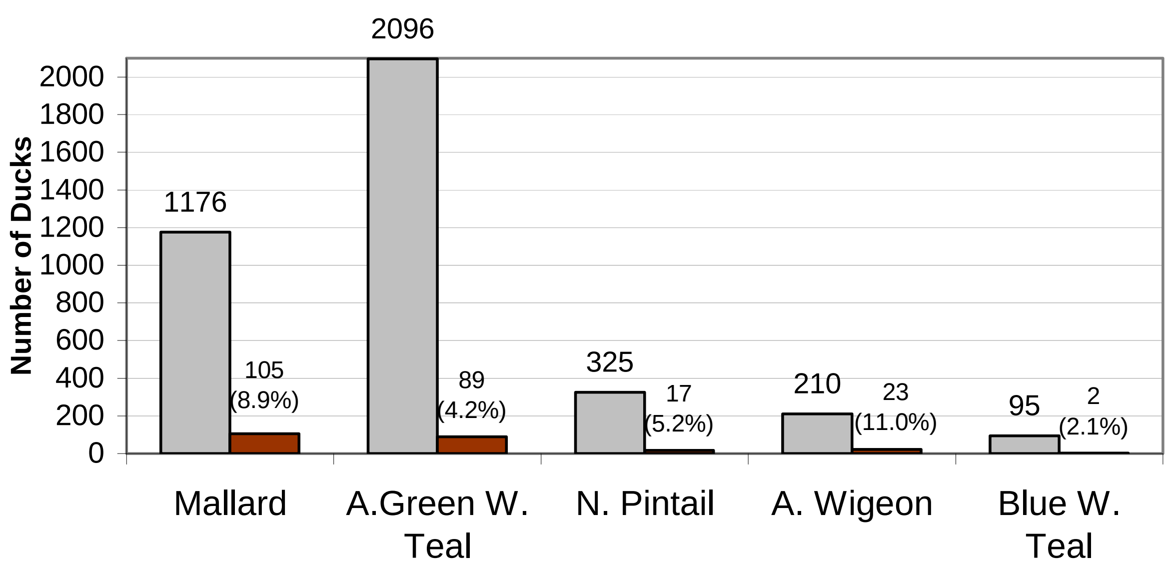
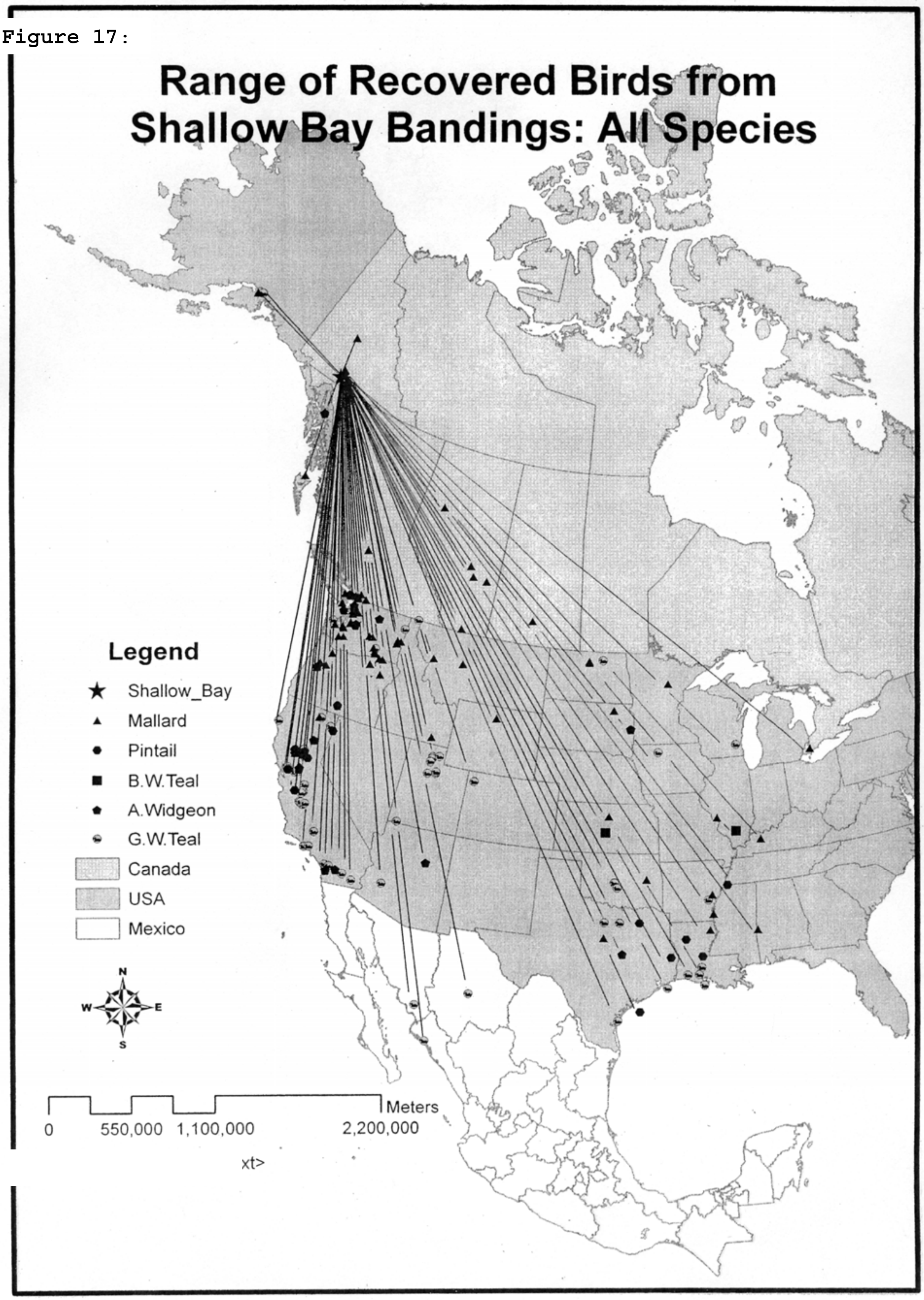


Figure 18. Shallow bay Ducks banded and recovery rates from elsewhere in N.A.

Figure 17:



Range of Recovered Birds from Shallow Bay Bandings: All Species
Legend
Shallow_Bay
Mallard
Pintail
B.W.Teal
A.Widgeon
G.W.Teal
Canada
USA
Mexico
N
W
E
S
0
550,000
1,100,000
2,200,000
Meters
xt>

Recaptures at Shallow Bay: Of the 3917 ducks captured and banded at Shallow Bay, 519 were recaptured on location. Some ducks were captured up to eight times in the same season. The length of time between captures gives us a minimal estimate of the time ducks use the Bay. Ducks were recaptured up to 31 days after their original capture. The fact that some ducks use the area for more than four weeks indicates that Shallow Bay is an important staging area for some individuals (figure 19.) Usually the trap was functional from the beginning of the migration period to the end in both spring and fall. Generally, ducks moved on more quickly in the spring; staging at Shallow Bay for no more than a few days. On the other hand, migrating ducks staged at Shallow Bay for longer periods of time (31 days and up) during the fall, basically until freeze up.

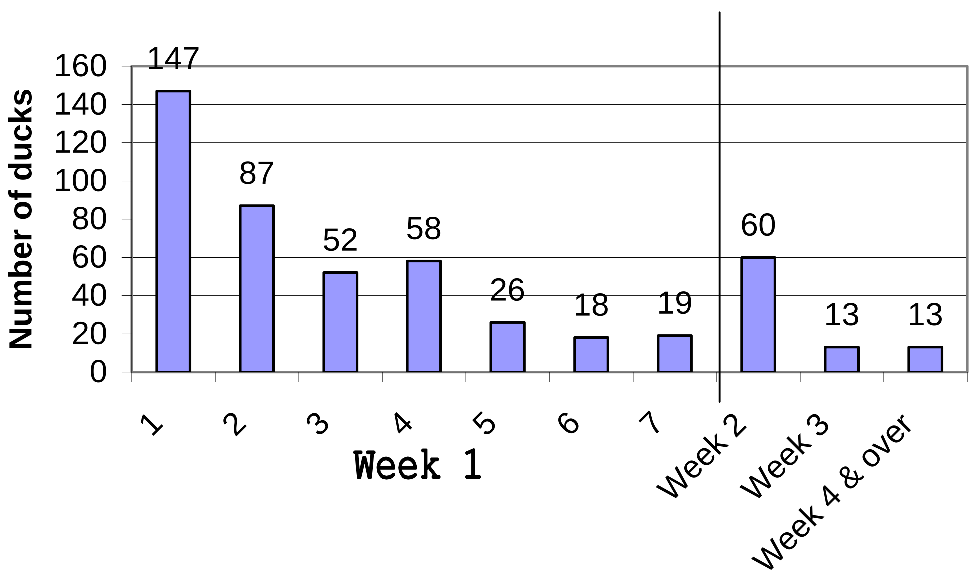


Figure 19: Number of recaptured ducks by time after first capture - Shallow Bay fall banding

Breeding numbers: At least four species of ducks and 1 gull species are known to breed on the area (table 4). The flooded willow community was the key habitat used by broods. It provides excellent cover, but also makes their census extremely difficult. In the summer of 2006, 13 broods were sighted at Shallow Bay. The ducks seemed to be utilizing the upper edge of the willow and Horse Creek as prime brood habitat (figure 20). A full survey of Horse Creek, its riparian habitat, and of the whole willow community would be key in determining the full productivity of this wetland.

Table 4: Broods Sighted at Shallow Bay in 2006

SPECIES	24-Jun	29-Jun	1-Jul	11-Jul	*Legend:*
Mallard		4b	1b	1f+1b	*b=brood*
Am. Widgeon	1f+1b		2a+1b	3b	*f-female*
N. Pintail		1b			*a-adult*
G.W. Teal		1f+1b	1f+1b		

Figure 20. A mother American Wigeon with her brood of 9 ducklings at the outer limit of the riparian willow community.

Moult: Flocks of diving ducks, primarily Lesser Scaup, use the area for moulting. The sedge and willow communities are also used by unknown numbers of moulting dabblers. In early summer 2007 a minimum of 200 male mallards were frequenting the general area apparently in preparation for moulting. Again, the use of the flooded willow community by moulting ducks makes them very safe from predation but almost impossible to survey.

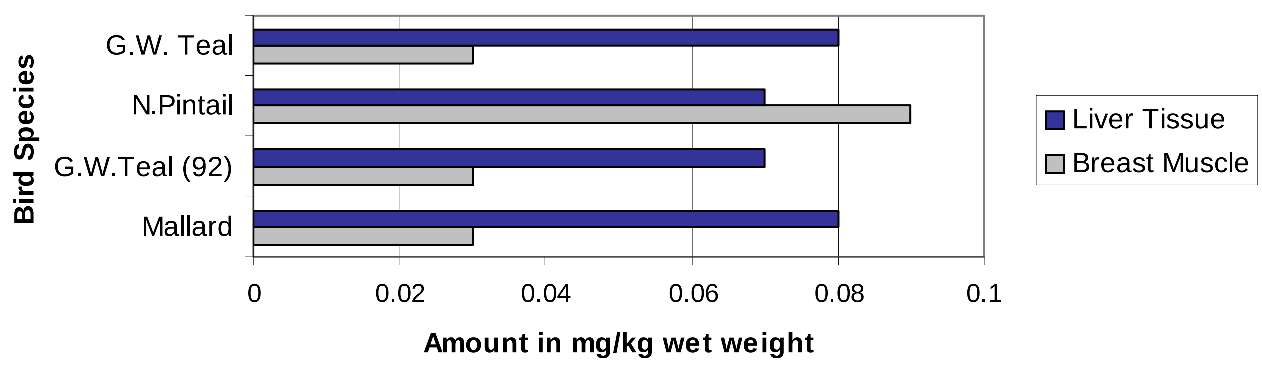
Toxin analysis in staging waterbirds:

In May of 1992 and 1994, the second author collected breast muscle and liver samples at Shallow Bay from various duck species for chemical residue analysis. “The Canadian Wildlife Research Centre” analyzed the samples, and the results were received in 1996 (figures 20-22).

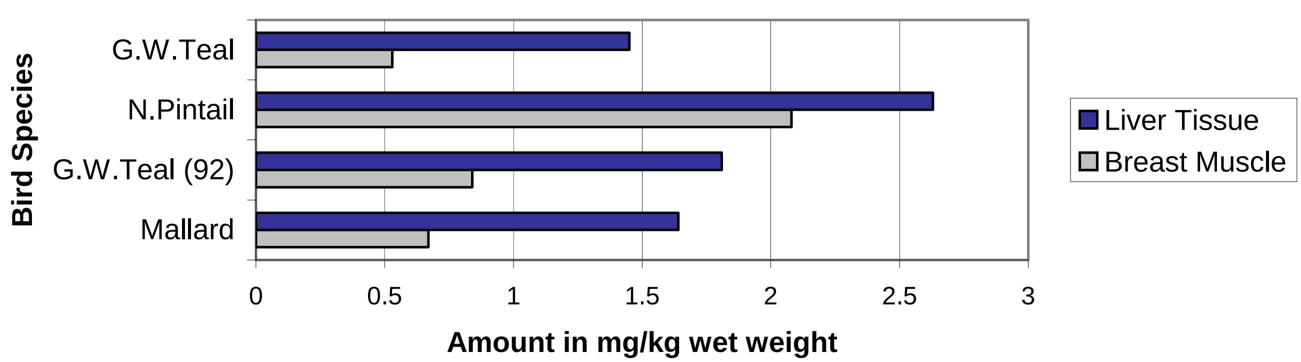
The analysis revealed different pesticides and heavy metal concentrations in the three duck species analyzed: Mallard, G.W.Teal, and N.Pintail. Full results of the analysis are found in Appendix 3. Since these ducks were all collected in the spring they most likely picked up contaminants in their southern wintering grounds. The meaning, or significance, of these numbers is not totally clear. Although it is known that high levels of contaminants are harmful to human health, the effects of lower level are still unknown. Whether the toxin levels are high enough to affect the water birds is uncertain. The liver and the fat are the places where toxins accumulate most.[1] Figure 20, 21 and 22 show concentration levels of Arsenic, Selenium, and DDT found in three waterfowl species.

[1] As a precaution, caution should be exerted when eating the liver of waterfowl. Limiting the intake of this part of the bird, until more is known may be wise.

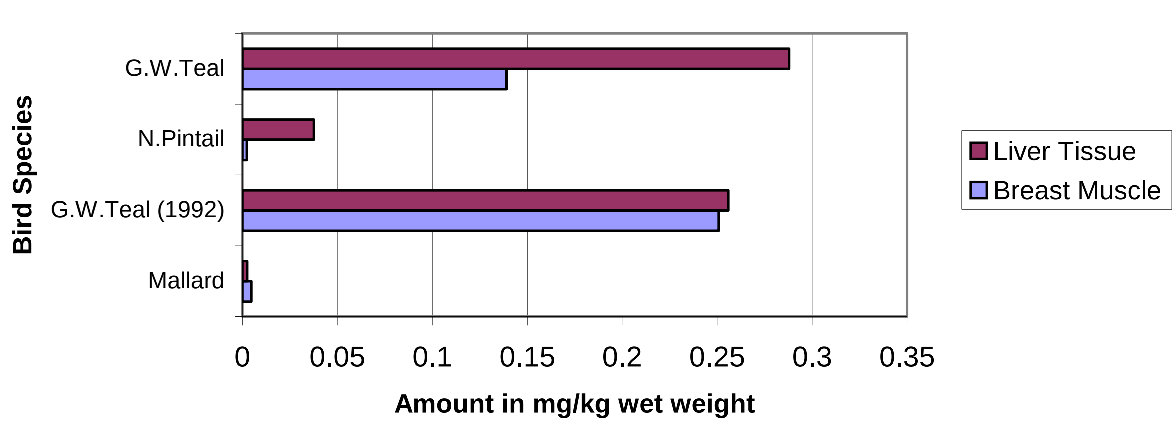
Figure 21. Arsenic Level Found in the Liver and Breast Muscles



Selenium Levels Found in the Liver and Breast Muscles



Sum of DDTs in Liver and Breast Muscles



Interestingly, the American Green-winged Teal is the species with the greatest concentration of DDT in its tissues. Although DDT use was banned from Canada and USA, very closely related chemicals are still used in Mexico, where this dabbler mainly winters. These high levels are undoubtedly attributed to the DDT pollution level in their wintering environment.

USE BY OTHER SPECIES:

SONGBIRD POPULATIONS:

The thick willow community surrounding Shallow Bay wetland is a very rich and productive area for a high concentration of songbird species. The willows provide breeding habitat and protection from predators. The flat and periodically flooded stretch between the water's edge and the willows is a nesting habitat for ground nesting birds such as; Savannah Sparrow, Least Sandpiper, and Herring Gull. (Annotated list of all birds sighted at Shallow Bay in Appendix 4.)

The 2006 Survey: Our principal field procedure to identify the different songbirds present in the area was through listening transects. In June, the authors repeatedly walked a transect along the willow's edge, from the road to Horse Creek, and up the creek, while listening to the different birds signing. Only the birds within 100m of transect were recorded. The numbers of songbird recorded provided the basis to estimate the total songbird population at Shallow Bay. Results are listed in Table 5. All the birds sighted or heard during other types of surveys are part of the survey report found in Appendix 1.

Figure 23. A Pine Grosbeak using the shelter from willow cover in July at Shallow Bay.

Table 5

Minimum Estimate of Breeding Songbird Population at Shallow Bay 2006	
Species	**Minimum estimate of signing males:**
Chipping Sparrow	8
Fox Sparrow	30
Savannah Sparrow	38
White-crowned Sparrow	16
Tree Sparrow	2
Dark-eyed Junco	20
Tree Swallow	4
Northern Flicker	4
Black Pole Warbler	16
Orange Crowned Warbler	2
Yellow Warbler	22
Yellow-rumped Warbler	10
American Robin	14
Hermit Thrush	18
Yellow Warbler	2
Black-caped Chickadee	6
Pine Grosbeak	2
Black-billed Magpie	6
Total estimated pairs:	**220**

Assuming a singing male is an indicated breeding pair, about 440 songbirds would have been breeding in the area in 2006.

Raptors: The raptors are powerful top-of-the-food chain indicator species for assessing the complexity and general productivity of an ecosystem. Bald eagles were seen hunting the area on a daily basis, and American kestrels were sighted twice in the summer of 2006. There is one record of Northern Goshawks nesting, raising 2 young at Shallow Bay in 1998.

Table 5.

Raptor sightings on the Shallow Bay wetland 1985-2006

American Kestrel	Common
Bald eagle	Common
Gyrfalcon	1-2 observations
Merlin	Uncommon
Northern Goshawk	Uncommon
Northern Harrier	Common seasonally

FISH POPULATION:

The waters of Shallow Bay are connected to those of the Yukon River, Lake Laberge, Horse Creek, and to the Takhini River. Bi-directional movement of fish is possible between all of these water bodies. On a bigger scale, Shallow Bay is part of the Yukon River drainage basin. Von Finster (2006) found the shallow warm waters of Shallow Bay to be an important nursery, rearing, and feeding habitats for various species of fish that contribute to

Lake Laberge’s overall fish stock productivity. At least 9 species of fish were found in the waters of Shallow Bay (table 6). There are very few records of fish surveys or fisheries within the bay. Some very preliminary surveys were conducted at Shallow Bay in 1985 and 1986. The survey method was seine netting. There are good verbal accounts of the traditional fishing, which went on for many years, by the Ta’an Kwäch’än first nation.

Table 7. Known Fish Species in Shallow Bay

Burbot	*Lota lota*
Chinook salmon	*Oncorhynchus tshawytscha*
Grayling	*Thymallus arcticus*
Lake chub	*Couesius plumbeus*
Lake whitefish	*Coregonus clupeaformis*
Least cisco	*Coregonus sadinella*
Longnose sucker	*Catostomus catostomus*
Northern pike	*Esox lucius*
Round whitefish	*Prosopium cylindraceum*

Table 6. Fish species encountered at Shallow Bay in the 1985-86 survey (conducted by A. von Finster)

Species	Sum of stomach contents across all fish species
Longnosed sucker Lake humpback whitefish Round whitefish Northern Pike	Worms, snails, whitefish, shrimp, invertebrates, fish eggs, leaches. One small Chinook salmon, and sculpins.

2006 survey: In July, a juvenile fish survey was conducted by Al von Finster, Jody Mackenzie-Grieve (Resource Restoration biologists with DFO) and the first author. Juvenile fish were collected with dip nets from a boat, and from the water's edge. In early August, a juvenile fish survey was conducted with the help of Clive Osborne. Small juveniles were captured with dip nets mostly within the flooded shrub community.

In July, young fish were found in and collected from large schools, on the South side of the bay. The fish were found in and at the outer margin of the shrub zone. Some fish were collected and preserved for later study. From a boat fish were sighted around 40 meters from the North shore where water depth reached 1m. Here, slivery, free-swimming fish, less than 100mm long, were sighted. Two specimens were captured, and preserved. Travel up Horse Creek was attempted, but a barbwire fence soon blocked the way. Small fish were sighted, but the attempts to capture them were unsuccessful.

Table T. Identitication of fish collected at Shallow Bay

Location	Species	Length
(a)	Longnose suckers-*Castostomus catastomus*	19.5-28 (mm)
(b)	Least cisco-*Corigonus artedi*	
(c)	Longnose suckers-*Castostomus catastomus*	

In August on all surveys, many young pike were sighted along and inside the willows' edge. Apparent size seemed to diminish along with the depth of the water. Thousands of meso-larvae fish were sighted well inside the willows' edge, and close to the water margin. Sizes ranging from 1" to 5", they were sighted in shallow waters (1½" to 10" deep). Some were visually identified as young pike; the others were mostly identified as sucker spps. During the GPS survey, fish were sighted literally every time the water's edge was approached. Many adult size fish were seen swimming off in a splash as we approached. These larger fish were seen well into the willows, undoubtedly feeding on the abundance of juvenile fish populating these shallow waters.

Some of the small fish sighted well inside the willows' edge, and close to the water margin, were most likely Lake chub (*Couesius plumbeus* - the Yukon River's only true minnow) (A. von Finster, 2006). Their presence, so high in the willows, would most likely be due to adult fish laying their eggs at water's margin. The eggs would have developed quickly in the warmer water and the weak proto-larvae would have then been carried higher into the willows with the rising water (A. von Finster, pers.comm. 2006). Presumably this egg-laying strategy allows the young fish to continuously be carried up into new nutrient-rich habitat that the willows' edge provides.

This further underlines the importance of these border regions, which may be easily disturbed by human activity. Development or repeated activity on the water's edge, or destruction of the willow stand will most likely have a direct negative impact on the juvenile fish using this area.

The remains of a burbot were observed on the shore of the lake, near the road. The Ta’an Kwäch’än people traditionally fished this species in the bay.

MAMMALS:

Beaver and muskrat:

A beaver dam was observed about 100 meters upstream of the bay on Horse Creek. In the summer of 2006 the dam seemed intact. Further upstream we found several dams in different stages of repair. The remainder of the wetland habitat is unsuitable for beaver occupation. Muskrat occured in small numbers; their strategies for dealing with the extreme water fluctuations are not understood.

Mustelids: Recorded were mink and short-tailed weasel.

Bears: (tracks and observation). A sow black bear and two cubs frequented the bay through the spring period one year. A grizzly was also sighted. Tracks were encountered regularly.

Moose and mule deer: (tracks only) The willow habitat is apparently used regularly by a small number of moose, and ample historic accounts of use suggest a larger number in the past. Mule dear tracks are also a common sight along the shores, and in the trails around Shallow Bay.

Figure 24. Moose track at Shallow Bay

OTHER WETLAND SPECIES:

Amphibians: Wood frogs were encountered regularly in the upper sedge community, and in mid summer throughout the flooded willow community. Since frogs are very susceptible to water pollution their presence at Shallow Bay is a positive indicator of the water's quality.

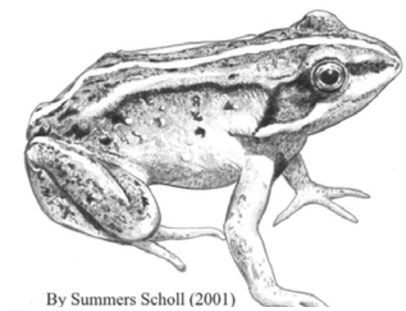


Figure 25. *Wood Frog*

Invertebrates: Samples of small invertebrates were often caught and brought up to the surface with a "clamp" used during the collection of the aquatic vegetation samples. Small white, brown and black clams, and a coiled white shell mollusc were observed, but no specimens were kept for later identification.

Figure 26. Ondata larvae captured during fish surveys 2007.

ACKNOWLEGEMENTS

Special thanks are due Katie Ostrum and Clay Martin who helped with fall banding, allowing free access to their land and generally adding their enthusiasm for the area. Bruce Bennett identified our plants, Al Von Finster and Jody Mackenzie-Grieve did fish collecting and identification, Clive Osborne helped us with the August fish survey, Sylvie Binette counted and banded ducks and reviewed an early draft of our report, Helmut Grumberg gave us his and other Bird Club records, and numerous people helped with the early banding and data collection on the area, notably: Bob Hayes, Kathy Egli, and Kris Gustafson.

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APPENDIX 1.

SHALLOW BAY WETLAND

CONSERVATION RECOMMENDATIONS:

SYNTHESIS and ASSESSEMENT: The key features of the Shallow Bay system are the interactions between the unique physical geology of the bay, the annual water level changes, and the vegetation communities.

MAJOR ECOLOGICAL FEATURES TO PROTECT:

HYDROLOGY: The natural regime of summer flood and fall drawdown must be maintained. The annual flooding of the emergent and riparian community is the cradle of life and diversity at Shallow Bay; it must be protected for the ecosystem to be kept healthy. In spite of the heavy flow of sediments in the Yukon River, the water of Shallow Bay remains relatively clear in summer (figure 8). This is likely a result of the inflow from Horse Creek directly into the bay, which continues year round; any change to its hydrology or water quality will have a profound effect on the habitat. The inflow of Horse Creek must be maintained. Since the ground is very flat and saturated, pesticides, or other toxins from adjacent human activities such as farming, will easily travel to the major water basin. Toxins and other pollutants inflowing from Horse Creek or the saturated soil would undoubtedly be deadly to the system and must be totally eliminated.

VEGETATION: All three riparian vegetation communities combined provide the key habitats for the inhabitants of Shallow Bay. The willow community in particular is probably one of the most important; its annual flooding may be one of the most important processes of the area's ecology. Furthermore, the willows provide food and shelter to young fish; food, shelter, breeding and nesting habitat for songbirds; and it provides shelter and rearing habitat to young waterfowl, as well as cover for moulting ducks.

DISTURBANCE: Staging and feeding during migration are critical processes without which wetland populations cannot exist. Undisturbed feeding and resting is key to the survival of waterbird species. It is probably going to be essential in the future to protect the bay from disturbances such as waterfowl hunting, and motorized access of all kinds. Motorized vehicle use on the floodplains at low water leaves deep scars in the soft substrate, and it was noted that very few plants grew there, months after the disturbance. In fact, in May of 2007 motorized track done years before were still visible at low water. The disturbance and destruction of the willow community, - as has been done by residential use and farming - must absolutely be avoided. Agricultural activity currently poses the greatest threat to the ecosystem's health and balance. Clearing essential habitat, and applying pesticides and fertilizers which leach out into the wetland, are the prime threats. Also tied to agriculture is the large continuous land surface exploitation that leads to habitat loss for bordering species.

Exotics: Any human occupation and utilization of an area involves the risk of exotic species introduction (intended or accidental). This introduction may be of plants or animals that do not usually occur in the territory, or it may also be from the Yukon species that are not native to Shallow Bay. Exotic species can change an area’s biodynamics by augmenting competition and pressure on the area’s original biodiversity, often leading to extinction of local species.

MANAGEMENT PLANNING:

PROPOSAL FOR A HABITAT PROTEDTION AREA (HPA) FOR SHALLOW BAY

Based on GPS locations of upper water levels and adjustments to historic levels available for Lake Laberge, it should be possible to protect the system adequately. The provisions both under the Yukon Wildlife Act and the Yukon Land Claim Final Agreement for the area are apparently adequate for moving toward protected habitat status for the area as a HPA.

We recognize a system with three major times of habitat use (spring, summer, fall) that are quite different: In spring the low water level allows feeding water birds and others, access to aquatics and benthic invertebrates that are produced primarily in the summer flood. In summer the flooding of the upper sedge marsh and the willow community provides excellent cover and highly productive shallow waters in vegetation and invertebrate food for fish and young birds. In fall the receding water allows access to the aquatic vegetation and benthic invertebrates that have meanwhile been produced during the summer high water period.

The Canadian Guidelines for determining boundaries of “Wetlands” recognizes the area of “saturated soil”. In the case of Shallow Bay because the substrate is flat lacustrine material, saturated soil is going to extend probably at least 100 meters beyond the highest watermark. Care must be taken to defend the entire habitat within: a buffer of perhaps 50 to 60 meters beyond the ‘saturated soil’ level should be protected (figure 29).

A large section of the TKC r-block 23B, the edges of other land already alienated, and most of AG applications 766 and 787-1 fall within this area and should be subject to protection if the Shallow Bay wetland ecosystem is to continue to functioning.

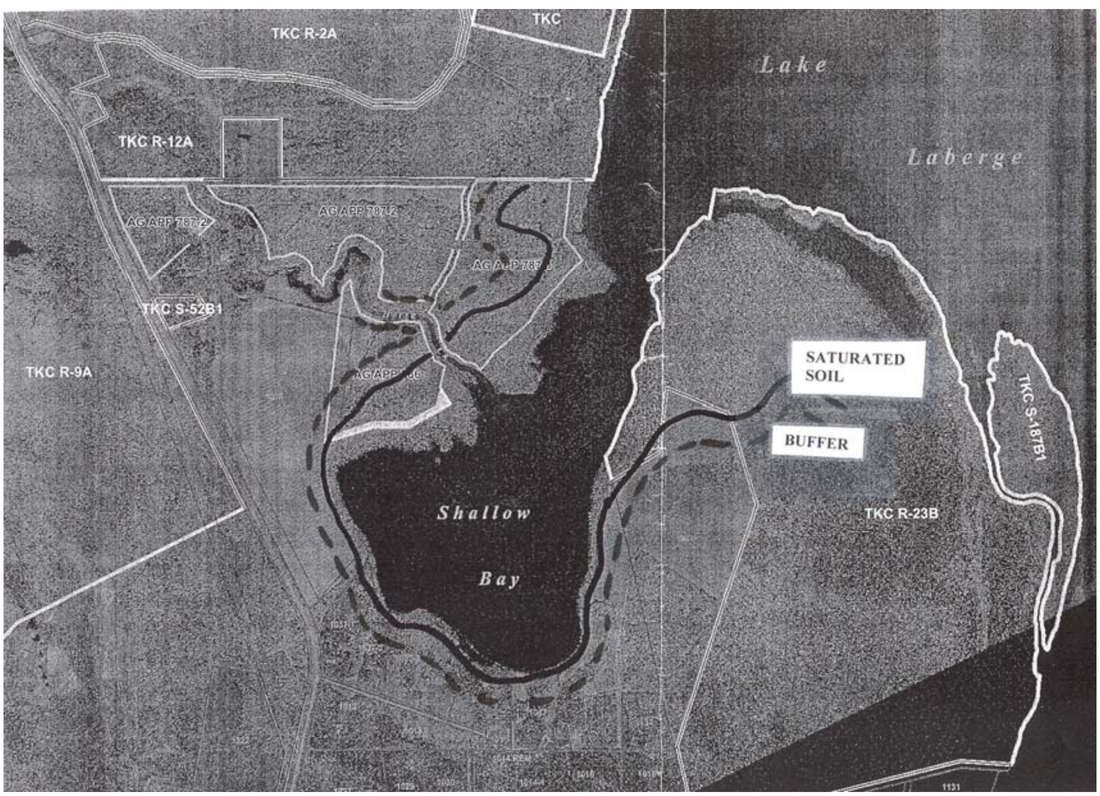

Figure 29. Shallow Bay showing upper saturated soil and suggested protection buffer

Management options for the future of Shallow Bay will undoubtedly involve a list of things but the immediate effort should be toward securing the area as a protected habitat. Things that may need attention in the future include:

a) Hunting restrictions will undoubtedly have to be implemented in the near future. Areas used currently are already far too close to occupied human dwellings and the small size of the area simply doesn't make hunting a wise use.

b) Water level manipulation: notably if artificial water regimes as a result of dams at Whitehorse and Marsh Lake continue to affect the area a hydrologic regime more in line with wetland needs may have to be established. (Ducks Unlimited, Canada developed one such proposal in the early 1980's).

c) Motorized access to the area will have to be controlled. Motorboat access is currently unrestricted and ATV use is likewise uncontrolled. Habitat destruction and more importantly, disturbance will undoubtedly have to be controlled in the future.

d) Educational use of the area will undoubtedly continue as the most important human use. Aids will have to be added in the future; public access, parking areas and interpretive material will greatly enhance the area's value. A boardwalk may be necessary to control access routes. Winter access can be controlled and assisted with set ski trails and other managed trails.

APPENDIX 2:

Annotated List of Bird Species: Shallow Bay Wetland, 1976-2007

SPECIES	YUKON BIRD CLUB	THIS STUDY'S OBSERVATIONS (1976-2007)
GREBES:		
RED-NECKED GREBE	X	Several sightings, no breeding
HORNED GREBE	X	Common, no breeding noted
WESTERN GREBE	X	
LOONS:		
COMMON LOON	X	Uncommon, no breeding
YELLOW-BILLED LOON	X	
PACIFIC LOON	X	Uncommon, no breeding
RED-THROATED LOON	X	
GULLS:		
LONG-TAILED JAEGER		1 sighting
GLAUCUS GULL	X	2 sightings
GLUCOUS-WINGED GULL		1 sighting
HERRING GULL	X	common, no breeding
MEW GULL	X	common, flying young being fed
BONAPART'S GULL	X	common, no breeding
ARCTIC TERN	X	common, no breeding
MERGANSERS:		
COMMON MERGANSER	X	uncommon, no broods noted
RED-BR. MERGANSER	X	uncommon, no broods noted
DABBLING DUCKS:		

MALLARD	X	common, broods, molting and staging both fall and spring
GADWALL	X	2 observation, no breeding'
EURASIAN WIGEON	X	
AMERICAN WIGEON	X	common, broods, molting and staging both fall and spring
AM. GREEN-W.TEAL	X	common, broods, molting and staging both fall and spring
BLUE-WINGED TEAL	X	uncommon, several sightings
CINNAMON TEAL	X	uncommon 2 sightings
NORTHERN SHOVELER	X	common, no breeding
NORTHERN PINTAIL	X	common, broods, molting and staging both fall and spring
DIVING DUCKS:		
REDHEAD	X	uncommon, several sightings
CANVASBACK	X	uncommon, several sightings
GREATER SCAUP	X	
LESSER SCAUP	X	common, staging and molting, no broods noted
RING-NECKED DUCK	X	uncommon, several sightings
COMMON GOLDENEYE	X	uncommon, spring sightings only, no breeding
BARROW'S GOLDENEYE	X	uncommon, few sightings
BUFFLEHEAD	X	common, no breeding noted
HARLEQUIN DUCK		
WHITE-WINGED SCOTER	X	uncommon, no breeding
SURF SCOTER	X	common, no breeding noted
RUDDY DUCK	X	
LONG TAILED DUCK	X	uncommon, no breeding
GEESE/SWANS		
GR. WHITE-FR. GOOSE	X	2 observations, late summer flocks
CANADA GOOSE	X	common, fall and spring staging
TUNDRA SWAN	X	common, fall and spring staging
TRUMPETER SWAN	X	common, fall and spring staging
SNOW GOOSE	X	1 observation
CACKLING GOOSE	X	
SANDHILL CRANE	X	uncommon, few sightings
SHOREBIRDS		
RED PHALAROPE	X	
RED-NECKED PHALAROPE	X	common, defending adults
WILSON'S PHALAROPE	X	
COMMON SNIPE	X	common, defending adults
LON-BILLED DOWITCHER	X	spring migrants fairly common
SHO-BILLED DOWITCHER	X	
STILT SANDPIPER	X	
PECTORAL SANDPIPER	X	spring migrants fairly common

BAIRD'S SANDPIPER	X	
LEAST SANDPIPER	X	common, defending adults
SEMIPAL. SANDPIPER	X	uncommon, spring migrants
WESTERN SANDPIPER	X	
HUDSONIAN GODWIT	X	
LESSER YELLOWLEGS	X	common, defending adults
GREATER YELLOWLEGS	X	
SOLITARY SANDPIPER	X	
WILLET		1 observation
WANDERING TATTLER		1 observation
UPLAND SANDPIPER	X	common, defending adults
SPOTTED SANDPIPER	X	common, defending adults
WHIMBREL	X	
BLACK-B. PLOVER	X	uncommon, spring migrants
AM. GOLDEN PLOVER	X	uncommon, spring migrants
PACIFIC GOLDEN PLOVER	X	
KILLDEER	X	uncommon, spring migrants
SEMIPALMATED PLOVER	X	common, defending adults

GROUSE

SPRUCE GROUSE	X	common, fall movements through area
RUFFED GROUSE	X	uncommon, few sightings'
WILLOW PTARMIGAN	X	

RAPTORS

NORTHERN HARRIER	X	common, no breeding noted
SHARP-SH. HAWK	X	common, no breeding noted
NORTHERN GOSHAWK	X	uncommon, no breeding record
RED-TAILED HAWK	X	common, no breeding, Harlan's type dominant
SWAINSON'S HAWK		1 observation
ROUGH-LEGGED HAWK	X	
GOLDEN EAGLE	X	uncommon, no breeding record
BALD EAGLE	X	common, young and adults , no nests in immediate area
GYRFALCON		1 observation
PEREGRINE FALCON		1 observation
MERLIN	X	uncommon, no breeding record
AMERICAN KESTREL	X	uncommon, no breeding record
OSPREY	X	uncommon, no breeding record
SHORT-EARED OWL	X	uncommon migration records only
BOREAL OWL		several observations
GREAT HORNED OWL	X	several observations
SNOWY OWL	X	
NORTHERN HAWK-OWL		1 observation

BELTED KINGFISHER	X	common, no breeding records

WOODPECKERS		
HAIRY WOODPECKER	X	common,
DOWNY WOODPECKER	X	common
THREE-TOED WODPECKER	X	uncommon,
YL-BELLIED SAPSUCKER	X	common
NORTHERN FLICKER	X	common
COMMON NIGHTHAWK	X	uncommon, no breeding known
FLYCATCHERS		
SAY'S PHOEBE	X	common, breeding in area
OL.-SIDED FLYCATCHER	X	common, breeding in area
WESTERN W. PEEWEE	X	common, breeding in area
ALDER FLYCATCHER	X	common, breeding in area
LEAST FLYCATCHER	X	common, breeding in area
HORNED LARK	X	uncommon, migration records
JAYS		
BLACK-B. MAGPIE	X	common, breeding in area
GRAY JAY	X	common, breeding in area
COMMON RAVEN	X	common, breeding in area
BROWN-H COWBIRD	X	common, breeding in area
RED-WINGED BLACKBIRD	X	common, breeding in area
RUSTY BLACKBIRD	X	uncomon, fall flocks only
EVENING GROSBEAK		2 observations
PINE GROSBEAK	X	common, breeding in area
PURPLE FINCH	X	common, breeding in area
RED CROSSBILL	X	common, breeding in area
WHITE-W. CROSSBILL	X	common, breeding in area
HOARY REDPOLL	X	
COMMON REDPOLL	X	common in fall and spring migration
PINE SISKIN	X	common, breeding in area
SNOW BUNTING		common in fall and spring migration
LAPLAND LONGSPUR	X	common in fall and spring migration
SMITH'S LONGSPUR	X	
SPARROWS		
SAVANNAH SPARROW	X	common, breeding in area
WHITE-CRND SPARROW	X	common, breeding in area
GOLDEN-CRND SPARROW	X	uncommon, few sightings in spring
AM. TREE SPARROW	X	common, breeding in area

CHIPPING SPARROW	X	common, breeding in area
DARK-EYED JUNCO	X	common, breeding in area
LINCOLN'S SPARROW	X	common, breeding in area
FOX SPARROW	X	common, breeding in area
SWALLOWS		
CLIFF SWALLOW	X	common, breeding in area
BARN SWALLOW	X	common, breeding in area
TREE SWALLOW	X	common, breeding in area
VIOLET-GREEN SWALLOW	X	common, breeding in area
BANK SWALLOW	X	common, breeding in area
BOHEMIAN WAXWING	X	common, no breeding known
NORTHERN SHRIKE	X	uncommon, several sightings in fall
WARBLING VIREO	X	uncommon, breeding in area
WARBLERS		
OR. CRND. WARBLER	X	common, breeding in area
YELLOW WARBLER	X	common, breeding in area
YEL-RUMPED WARBLER	X	common, breeding in area
BLACKPOLL WARBLER	X	common, breeding in area
NORTHERN WATERTHRUSH	X	common, breeding in area
COMMON YELLOWTHROAT	X	common, breeding in area
WILSON WARBLER	X	common, breeding in area
AMERICAN PIPIT	X	common in fall and spring
RED-BR. NUTHATCH	X	uncommon, probably breeding
BLACK C. CHICKADEE	X	common, breeding in area
BOREAL CHICKADEE	X	common, breeding in area
GOLDEN-CRND KINGLET	X	uncommon in fall and spring
RUBY-CRND KINGLET	X	common, breeding in area
THRUSHES		
TOWNSEND'S SOLITAIRE	X	uncommon, fall and spring
SWAINSON'S THRUSH	X	common, breeding in area
HERMIT THRUSH	X	common, breeding in area
AMERICAN ROBIN	X	common, breeding in area
VARIED THRUSH	X	uncommon, fall and spring

MOUNTAIN BLUEBIRD	X	uncommon, breeding in area
EUROPEAN STARLING	X	

APPENDIX 3:
SHALLOW BAY VEGETATION IDENTIFIED 2006-7 (Identified by B. Bennett)

Aquatic
Callitriche verna – Vernal Water-starwort
Chara –Stonewort family
Potamogeton alpinus – Alpine Pondweed
Potamogeton filiformis – Fine-leaved pondweed
Potamogeton friesii – Fries' Pondweed

Potamogeton richardsonii – Richardson's pondweed
Utricularia vulgaris – Common Bladderwort

Emergent/Periodically flooded

Astragalus alpinus – Alpine Milk-vetch
Calamagrostis canadensis – Bluejoint Reed Grass
Carex saxatilis – Sedge family
Carex utriculata – Sedge family
Equisetum arvense – Field horsetail
Euphrasia subarctica – Arctic eyebright
Hippuris vulgaris – Common mare's-tail
Poa palustris – Fowl-meadow grass
Potentilla palustris – Marsh fivefingers
Rumex occidentalis – Western dock
Salix arbusculoides – Willow family
Salix bebbiana – Long-beaked willow
Salix glauca – Blue-green willow
Salix planifolia – Willow family
Senecio pauciflorus – Groundsel family

Stellaria longifolia - Long-leaved starwort (chickweed)
Triglochin maritimum - Seaside arrow-grass
Triglochin palustre – Marsh arrow-grass

Wetland Edge / Terrestrial

Achillea millefolium var borealis – Common Yarrow
Allium schoenoprasum – Wild onion
Astragalus eucosmus – Elegant Milk-vetch
Barbarea orthoceras – Winter Crescent
Calamagrostis ssp. – Reed Grass specie
Deschampsia caespitosa – Tufted hair grass
Gentiana amarella ssp. acuta – Felwort
Gentianella propinqua – Four-parted Gentian
Hordeum jubatum - Foxtail
Oxytropis campestris ssp. varians – Northen Yellow Locoweed
Oxytropis deflexa ssp. sericea – Pendant-pod Locoweed
Populus balsamifera - Balsam Poplar
Populus tremuloides - Trembling aspen
Rhinanthus crista-galli – Yellow-rattle
Rosa acicularis – Wild Rose
Senecio indecorus – Rayless Mountain Groundsel
X Elyhordeum macounii – Wild rye hybrid

APPENDIX 4:
Tozxins identified from Shallow Bay water birds

Tissue: BM - Breast Muscle; LIV – Liver
Sum CB's **=** Sum Chlorobenzenes (1,2,3,5 & 1,2,3,4 Tetrachlorobenzene, Pentachlorobenzene and Hexachlorobenzene)
Sum HCH's **=** Sum of a-, b- & g- hexachlorocyclohexanes
Sum Chlordanes **=** Sum of oxy-, trans- & cis-chlordane, trans- & cis-nonachlor and heptachlor epoxide
Sum DDT's **=** Sum of pp'-DDE, pp'-DDD and pp'-DDT
Sum Mirex **=** Sum of Photo-mirex and Mirex
Sum PCB's **=** Sum of PCB congeners 28, 31, 44, 52, 60, 66/95, 87, 97, 99, 101, 105, 110, 118, 138, 141, 146, 153, 170/190, 171, 172, 174, 180, 182/187, 183, 194, 195, 201, 203, 206
As = Arsenic; **Se =** Selenium; **Hg =** Total Mercury; **Cd =** Cadmium

Tiss	Species	#	Lipid %	Water %	QCB	HCB	Sum CB
BM	Mallard	7	2.40	70.2	0.0000	0.0005	0.0005
LIV	Mallard	7	3.10	72.5	0.0000	0.0005	0.0005
BM	Green-winged Teal (92)	7	1.80	71.4	0.0008	0.0201	0.0209
LIV	Green-winged Teal (92)	7	2.80	75.9	0.0006	0.0158	0.0164
BM	Northern Pintail	2	2.40	69.8	0.0000	0.0008	0.0008
LIV	Northern Pintail	2	5.40	69.4	0.0005	0.0012	0.0017
BM	Green-winged Teal	4	2.40	71.6	0.0007	0.0039	0.0046
LIV	Green-winged Teal	4	2.70	70.6	0.0009	0.0063	0.0072

b-HCH	Sum HCH	OCS	oxy-chlordane	Trans- chlordane	Trans-nonachlor	Heptachlor epoxide
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000	0.0000	0.0003	0.0017	0.0000	0.0008	0.0011
0.0010	0.0010	0.0000	0.0025	0.0000	0.0013	0.0009
0.0011	0.0011	0.0024	0.0130	0.0000	0.0064	0.0070
0.0000	0.0000	0.0000	0.0006	0.0000	0.0000	0.0009
0.0000	0.0000	0.0000	0.0021	0.0000	0.0012	0.0051
0.0009	0.0009	0.0000	0.0011	0.0000	0.0000	0.0009
0.0024	0.0024	0.0009	0.0101	0.0004	0.0012	0.0117

Sum Chlordanes	pp'-DDE	pp'-DDD	Sum DDT's	Photo-mirex	Mirex	Sum-Mirex
0.0000	0.0047	0.0000	0.0047	0.0000	0.0000	0.0000
0.0036	0.0025	0.0000	0.0025	0.0000	0.0000	0.0000
0.0047	0.2487	0.0021	0.2508	0.0000	0.0010	0.0010

0.0264	0.2539	0.0019	0.2558	0.0006	0.0016	0.0022
0.0015	0.0024	0.0000	0.0024	0.0000	0.0000	0.0000
0.0084	0.0365	0.0012	0.0377	0.0000	0.0000	0.0000
0.0020	0.1373	0.0018	0.1391	0.0000	0.0009	0.0009
0.0234	0.2832	0.0046	0.2878	0.0000	0.0000	0.0000

			METALS:			
Dieldrin	**Aroclor 1254:1260**	**Sum PCB's**	**As**	**Se**	**Hg**	**Cd**
0.0000	0.0000	0.0024	<0.03	0.67	<0.03	<0.08
0.0006	0.0152	0.0044	<0.08	1.64	0.34	0.46
0.0002	0.1593	0.0749	<0.03	0.84	0.09	<0.08
0.0047	0.3152	0.1240	<0.07	1.81	0.20	0.22
0.0003	0.0000	0.0013	<0.09	2.08	<0.12	<0.18
0.0051	0.0114	0.0046	<0.07	2.63	0.09	0.90
0.0025	0.0124	0.0032	<0.03	0.53	0.67	<0.08
0.0575	0.0137	0.0043	<0.08	1.45	2.22	0.32

T4CB	0.0000 in all species
a-HCH	0.0000 in all species
g-HCH	0.0000 in all species
cis-chlordane	0.0000 in all species
cis-nonachlor	0.0000 in all species
pp'-DDT	0.0000 in all species

APPENDIX 5:
Water Level Peak Dates Since 1980 at Shallow Bay

Year	Peak Date	Meters Above Sea level
1980	Aug 20	626.412m
1981	Sept 21	626.789m
1982	No Data	No Data
1983	Aug 19	626.164m
1984	Sept 04	625.895m
1985	Aug 07	626.41m
1986	Aug 02	626.923m
1987	Aug 14	626.353m
1988	Jul 30	626.845m
1995	No Data	No Data
1996	No Data	No Data
1997	Aug 27	626.397m
1998	Aug 05	625.937m
1999	Aug 22	626.216m
2000	Aug 26	626.874m
2001	Aug 07	626.577m
2002	Sep 09	626.126m
2003	No Data	No Data
2004	Aug 25	626.605m
2005	Jul 25	626.379m
2006	Aug 01	626.52m
2007	Aug 08	627.28m

Data from: Water Survey Canada